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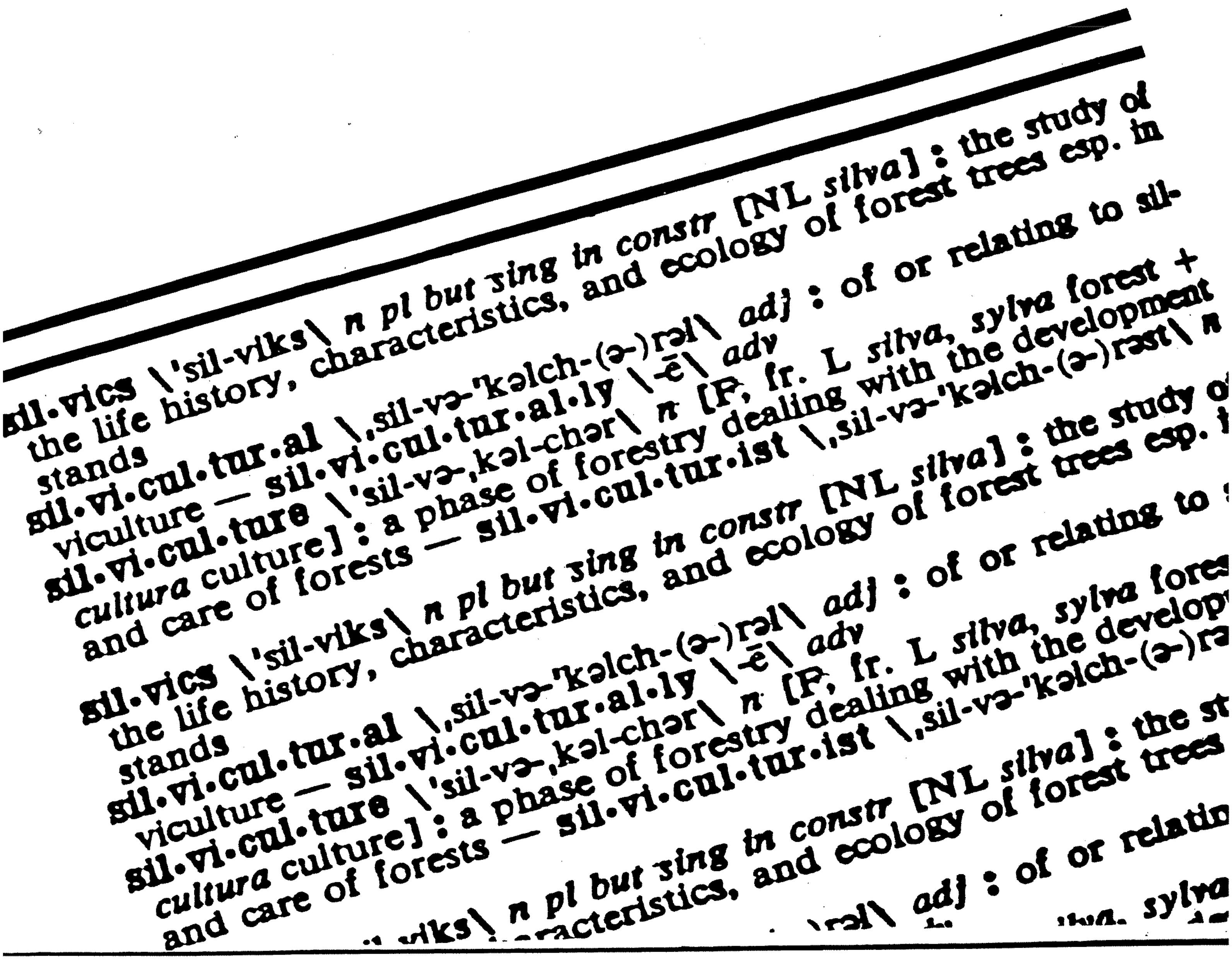

EFFECT OF HARVEST METHOD ON NUTRIENT RESOURCES IN SAND PINE SCRUB[1]

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Abstract—Ocala sand pine, *Pinus clausa* var. *clausa* D.B. Ward, scrub grows on relatively poor sandy soils with low nutrient reserves. A windrow tree-length harvest system with limbing spread across the site ~~and a full-tree harvest system using limbing gates at strategic locations were compared. With the limbing~~ gate system 66 percent of the crown material is concentrated in a few large piles with nutrients unavailable to most of the area. Nitrogen reserves and inputs are sufficient to sustain both harvest systems for some time. Phosphorus losses however, could decrease site productivity with the full-tree limbing gate system because of the losses from removal of crown material.

INTRODUCTION

Sand pine, *Pinus clausa* (Chapm. ex Engelm.) Vasey ex Sarg., is a major component of the scrub native to sandhills sites of Florida and Baldwin County, Alabama. The largest concentration of the Ocala variety grows in the center of Florida on an area of rolling sandhills known as the Central Highlands. The Choctawhatchee variety, *P. clausa* var. *immuginata* D.B. Ward, is found along the Gulf Coast of northwest Florida from the Apalachicola River westward into Alabama (Little, 1979). Although a minor southern pine, sand pine is important in Florida where it is the dominant tree species on approximately 1.2 million hectares (Eyre, 1980).

Scrub grows on sandy marine deposits formed as dunes, bars and spits, mostly during the Pleistocene epoch of fluctuating sea level. These sandhills have infertile soils consisting largely of deposits of quartz sands, ranging from a meter to more than 7 meters deep. Organic matter content is low because the climate promotes rapid oxidation. Because of the low levels of organic matter and of clay colloids, cation exchange capacities, and thus nutrient retention, of these soils are low (Burns and Hebb, 1972). Poor sites, like these deep, infertile sands and shallow soils over bedrock, have the greatest immediate potential for site productivity declines due to whole-tree harvesting (Boyle et al. 1973, Green and Grigal 1980, Jorgensen et al. 1975, Waide and Swank 1976, Weetman and Weber 1972). The objective of this study was to determine the nitrogen and phosphorus losses from sand pine scrub harvested by two different methods.

METHODS

Nutrient removals were evaluated based on two harvest systems routinely used for sand pine (Outcalt 1988). With the full-tree limbing gate system, although only the bole is used, the entire tree is removed and limbs are removed at a few convenient locations leaving the crown in a few large piles. Samples were collected across a typical 40 hectare site harvested by this method on the Ocala National Forest, Florida. The 50 year old stand that was harvested had 530 sand pine per hectare with an average diameter of 16.75 cm and an average height of 12.9 m. Based on the distribution of biomass in sand pine trees (McNab et al. 1985) the stand should have contained 11,000 kg/ha of crown material.

The windrow system is a tree-length method removing only the bole. Limbing, however is done after the trees are gathered in windrows spread across the entire harvest area. Samples were collected from two sand pine stands age 37 and 42 years with 435 trees/ha, average diameter 17.5 cm, and average height 13.1 m. Based on stand data there was 10,200 kg/ha of crown material in these stands prior to harvest.

All fresh crown material was collected immediately after harvest from thirty randomly located 1 m square samples plots on each of the three sites. This fresh crown material was bagged, returned to the laboratory and dried at 65 ° C and weighed. Nitrogen and phosphorus content of sand pine are based on samples collected from 60 Ocala sand pine trees harvested for an earlier study (Rockwood et al. [illegible]). Trees were selected in a stratified random system based on diameter distribution. Selected trees were felled and divided into stem and crown portions. The crown was further divided into three equal length sections of lower, middle and upper. Each section of the crown and the bole were weighed and subsamples were collected for dry weight and nutrient determinations. After drying, material was ground [illegible]

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wiley mill. A subsample of each ground sample was taken with a riffle sampler for nutrient analyses. Nitrogen (N) was determined on 1 g samples by the micro kjedahl method and phosphorus (P) was measured with a spectrophotometer after dry ashing and dissolving in acid.

Potential nutrient losses or removals with these different harvest systems were estimated as follows. The average diameter and height of sand pine were inserted into the equations from McNab et al. (1985) to calculate the biomass of the various tree components. Crown and stem weights were then multiplied by the percent N and P for Ocala sand pine based on analyses of samples collected from the 60 trees. Lastly, these numbers were multiplied by the number of trees to estimate the amounts of N and P per unit area in the various portions of sand pine stands. Finally the potential removals under different harvest systems were calculated by adding the contents of N and P for the appropriate tree components together.

RESULTS AND DISCUSSION

Based on information from Brendemuehl (1968) estimated soil reserves of N and P for a typical sandhills soil are 3600 kg/ha of total N and 3.5 kg/ha of available P to a depth of 2 meters. Because there is little iron and aluminum in these sandy soils (Pritchett, 1979) most of the P is contained in the soil organic matter. The N to P ratio for sandy soils is 10:0.2 – 0.4 (Russell, 1973) giving an estimate of 72 to 108 kg/ha for total P. Total P can alternatively be estimated by assuming that about 3 percent of the soil organic matter cycles each year to maintain the 3.5 kg/ha of available P, which gives an estimate of total P of 117 kg/ha.

Nutrient inputs are mainly from precipitation and dust. Total N inputs range from 1 to 2 kg/ha/yr in western locations (Sollins et al., 1980) to 13 kg/ha/yr at sites near major industrial centers (Henderson et al., 1978) and average about 5.6 kg/ha/yr in Florida (Burger, 1979). Phosphorus inputs are smaller but just as variable ranging from 0.1 in Ontario (Foster and Morrison, 1976) to 1 kg/ha/yr in Florida (Riekerk, 1981). Nutrients are removed from forest sites by water in either dissolved form or as sediments contained in runoff. Leaching typically removes only small amounts of elements from undisturbed forest systems (Fredriksen 1970, Riekerk et al. 1979). This is due to the internal conservative features of the forest. Although fair quantities of nutrients maybe leached from the forest floor, most are removed before the ground water has penetrated beyond rooting depth. Losses of nutrients by erosion and sediment removal are low in undisturbed forests. McColl and Grigal (1979) used data from various studies to derive estimated annual losses of N, K, Ca, and Mg of less than 0.1 kg/ha/yr. Since P is strongly adsorbed by soil particles, losses as sediment can be higher than in the dissolved form. However losses are still typically small at less than 0.2 kg/ha/yr (Duffy et al. 1978)

Dry weight of slash left on the full-tree limbing gate harvested site was 3,700 kg/ha. The rest of the crown material was concentrated at and adjacent to the three limbing and loading areas. Any nutrients in this concentrated crown material are now essentially unavailable. The two windrow tree-length harvested sites averaged 10,200 kg of crown material left on site. Although not distributed in an entirely even pattern, virtually all the crown was left on site where the nutrients will be available for use.

Based on the estimates derived by the above process (Table 1), harvest of sand pine from scrub sites should not cause a depletion of N reserves. Even with the full-tree limbing gate system, the atmospheric inputs are large enough to offset removals and result in an accumulation of nitrogen. The soil although poor does have a sizable nitrogen reserve. Assuming a turnover rate of only 1 percent per year, 36 kg/ha is available for use which should be adequate for estimated demands (Burger 1979, Gholz et al. 1985). Thus, either of the harvest systems with rotations of 35 plus years would not have nitrogen losses sufficient to reduce site productivity.

Table 1--Effect of different harvesting systems on nitrogen balance in Ocala sand pine under 40 year rotation

	Windrow Tree-Length Chip	Full-Tree Limbing Gate Chip
	----kg/ha----	
Soil Reserves		
0-8cm	300	300
8-200cm	3300	3300
TOTAL	3600	3600
Harvest Removal	24	68
Atmospheric Input	224	224
Change after Harvest	+200	+156

A very different situation exists for phosphorus. There are few P containing minerals in the soil to weather and P inputs are small and balanced by outputs so soil reserves must essentially supply the needed P. The reserves of P in the soil are significantly smaller than N reserves (Table 2). It appears that with the full-tree limbing gate harvest system P reserves will eventually be sufficiently depleted to cause a productivity decline. Pritchett and Morris (1982) concluded that phosphorus may become limiting after only a few rotations in intensively managed slash pine plantations on phosphorus poor soils of the southeastern coastal plain.

Table 2--Effect of different harvesting systems on phosphorus balance in Ocala sand pine under 40 year rotation

	Windrow Tree-Length Chip	Full-Tree Limbing-Gate Chip
	-kg/ha—	
Soil Reserves		
0-8cm	9	9
8-200cm	91	91
TOTAL	100	100
Harvest Removal	1	5
Change after Harvest	-1	-5

Considering the above estimates of reserves and potential removals of P under different harvesting systems, precautions need to be taken to avoid a long term reduction in site productivity. This means replacing the full-tree limbing gate harvest system which concentrates crown materials and therefore nutrients in piles with systems like the windrow technique where the crown is left distributed across the site. The crown material, especially the needles, are a valuable source of organic matter and nutrients. Thus, as for lodgepole pine forests in the northern Rocky Mountains (Entry et al. 1987), management should foster conservation of organic matter on sand pine scrub sites.

In addition placing the branches and needles in large piles removes nutrients from most of the site and creates a few areas with abnormally high concentrations. This artificial distribution of nutrients on the site will impact the scrub vegetation. Weedy, opportunistic species will likely be favored on the highly disturbed and relatively nutrient rich areas where crown materials are concentrated. The long-term effect on the scrub vegetation of this abnormal distribution of nutrients is unknown but ecologically inadvisable.

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